GPS Detects Vertical Surface Displacements Caused by Atmospheric Pressure Loading

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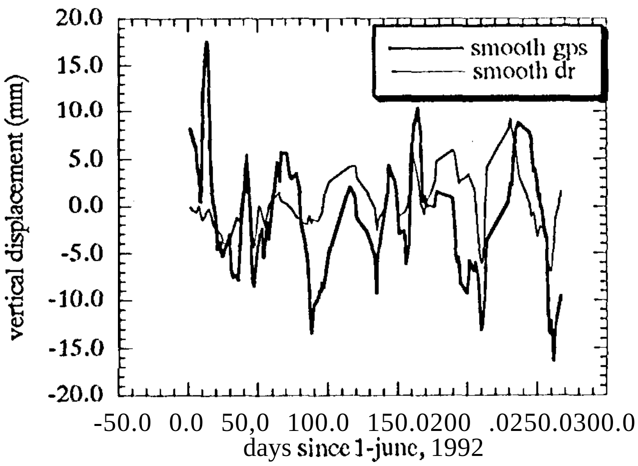
Tide gauge measurements only give sea-level variations relative to the crust, whereas the crust itself may be deforming vertically due to various factors. If vertical crustal deformation is ignored, then erroneous conclusions maybe drawn with regard to the causes and predictions of global sea-level change. However, if tide gauge measurements were sufficiently well tied to a stable Earth-centered reference frame using space-geodetic techniques, sea-level change could be observed in an absolute sense. We demonstrate bat GPS is an excellent candidate for addressing the geodetic aspects of global sea-level studies by looking at a physical phenomenon that should have a detectable and calculable effect on station heights. Temporal variations in the geographic distribution of atmospheric surface pressure deform the surface of the Earth at the several millimeter level. Starting with daily no-fiducial solutions of the global GPS network, we show a new method of deriving a time series of individual station heights (an improvement over the more usual geodetic baseline analysis). Atmospheric loading is modeled sing Farrells Green Functions, and using pressure values from the NCAR database (on a 2.5° grid). The following sample plot shows vertical displacement at Yellowknife, Canada, where both the modeled and GPS-estimated station heights are smoothed using a 7-day sliding window:



Out of the 7 stations we have investigated so far, 6 have a decreased RMS height variation after calibrating for modeled atmospheric loading. One of the questions currently under investigation is how to model the height variations of coastal sites (which are important for tide-gauge measurements). For coastal sites, the crustal response is a function of the extent of the inverted barometer effect, in which the ocean tends to act as a high-pass filter (τ = several days) in transmitting at mospheric pressure to the crust.

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